5

Medical Record Keeping

An Institute of Medicine committee studying the health consequences of the Persian Gulf War noted that "the single most troublesome problem encountered in attempts to conduct epidemiologic studies of illnesses among Persian Gulf war veterans has been the inability to retrieve information on medical care events such as hospitalizations, outpatient visits, and diagnosis and treatment from DoD and VA medical records in a uniform and systematic manner" (Institute of Medicine, 1996a, p. 128). The committee went on to state that "current systems are fragmented, disorganized, incomplete, and therefore poorly suited to support epidemiologic and health outcomes studies" (p. 128). As a result, the number one recommendation from the committee was to have the U.S. Department of Defense (DoD) and the U.S. Department of Veterans Affairs (VA) work together to develop a "single, uniform, continuous, and retrievable electronic medical record for each service person" (p. 10). They envisioned that the record should include all relevant health items, allow linkage to exposure and other data sets, and have the capability to incorporate relevant medical data from other institutions with appropriate confidentiality protections.

The Presidential Advisory Committee on Gulf War Veterans' Illnesses (1996b) directed the National Science and Technology Council (NSTC) to develop an interagency plan to address health preparedness for and readjustment of veterans and families after future conflicts and peacekeeping missions. NSTC recommended that DoD "implement a fully integrated computer-based patient record available across the entire spectrum of health care delivery over the lifetime of the patient" (National Science and Technology Council, 1998, p. 23). The goal was to "ensure the accuracy, timeliness, security, and retrievability of information that must be entered into records or automated systems that document personnel history for active, National Guard, and reserve service members and veterans" (p. 23).

In accordance with its charge, the study team reviewed DoD's approach to medical record keeping and provides recommendations to enhance the capability of information systems to support the health of deployed U.S. troops. As part of the review process, the study team held three workshops that covered various aspects of DoD's approach to medical record keeping. The study team also solicited advice from additional experts on medical information systems, Edward Hammond and Clement McDonald, who participated in DoD briefings and the review. The study team and other experts consider the computer-based patient record (CPR) essential for DoD to meet the health care needs of service members before, during, and after deployments (Institute of Medicine, 1997). Additional information systems are necessary to support population-based surveillance beyond medical record surveillance, such as for laboratory-based surveillance, reportable conditions, and disease non-battle injury (DNBI) reporting (Chapter 4). This chapter summarizes the study team's observations, findings, and recommendations.

While this study and report focused on the global needs for effective automation of military medical records, information is available elsewhere providing more detail about the current medical record keeping practices of the military services. A recent report provides information about specific medical record keeping practices during the Gulf War, how policies and practices have been modified to respond to identified problems, and plans for the future (Office of the Special Assistant to the Deputy Secretary of Defense for Gulf War Illnesses, 1999).

INFORMATION NEEDS OF THE MILITARY HEALTH SYSTEM

As the largest health care system in the world, the military health system has an extraordinary need to acquire, manage, analyze, and retain health information on recruits, active-duty personnel, reservists, and veterans. While care of the individual service member should be its first priority, the record-keeping system in the military health system must meet several needs simultaneously to fulfill the needs of Force Health Protection:

1. provide access to an individual's health data anytime and anywhere that care is required,
2. support record keeping for the administration of preventive health services,
3. facilitate real-time medical surveillance of deployed forces and timely medical surveillance of the total force,
4. provide comprehensive databases that support outcomes studies and epidemiological studies, and
5. maintain longitudinal health records of service members beginning with recruitment and extending past the time of discharge from the military.

Each of these requirements is briefly elaborated upon below.

Individual Care

Informed decision making requires access to comprehensive data on patients at the time that care is delivered. The mobile nature of military personnel, including deployments abroad, makes use of CPRs the only practical option. Because service members may be deployed to locations where access to the CPR may be problematic, other methods of providing necessary health information at the point of care must also be considered. It is unlikely, however, that large amounts of data are required outside of a medical treatment facility. For specific situations, such as medical evacuation, portable storage devices may be useful.

Preventive Care

Although preventive care is part of care to individuals, its universal application to members of the force (e.g., mass immunizations) and the need to track compliance with guidelines warrant special attention. Service members need immunizations to protect them from hazards associated with special deployments. These include immunizations against respiratory diseases prevalent in training camps, against natural disease hazards during deployments, and against biological warfare agents. CPR systems perform well when used to identify service members who are eligible for a specific preventive medicine service, remind health professionals to perform the service, and track members' health statuses (McDonald, 1976; McDonald et al., 1984, 1992; Shea et al., 1996; Tang et al., 1999). Reminder and tracking functions should be incorporated into the CPR to ensure the greatest possible integration of preventive medicine practices with routine care.

Another part of prevention is to "do no harm." Adverse drug reactions cause significant morbidity in hospitals (Bates et al., 1995; Leape et al., 1995; Classen et al., 1991; Lazarou et al., 1998). Adverse events also occur in the ambulatory care setting, including the military ambulatory care setting. Computer-based decision support associated with physician order entry can effectively reduce the incidence and costs of adverse drug interactions (Classen et al., 1991; Evans et al., 1993; Lee et al., 1996; Shiffman et al., 1999). Military CPR systems should include automated decision support to detect potential drug allergies and drug-drug interactions as well as other decision support functions (Johnston et al., 1994).

Medical Surveillance

In addition to providing data to support immediate care of individuals, the military health system must support ongoing medical surveillance of the military force to ensure maximal preparedness for the military mission and to detect health threats promptly. Useful information for surveillance will come not only from individual medical records, but also from sources such as mandatory reportable conditions, aggregate DNBI data, and laboratory databases. Consequently, the ability to consolidate data from all regions in the world must exist and must be available in a timely manner. To analyze aggregate data, common representation of data is required. At a minimum, common data definitions and common data models must exist for all relevant health items to be consolidated. Also, since the interpretation of data depends on how data are gathered, the use of common applications to acquire data increases the consistency of data collected at different locations.

The operational utility of surveillance data to commanders (particularly in theaters of operation where the risk of chemical or biological agents is high) depends on both the accuracy of the data and the timeliness with which commanders can access and interpret aggregate data. Real-time linkages between medical units and upper echelons of command are needed so that surveillance data can be used to detect and immediately respond to health threats.

Correct interpretation of real-time surveillance data during an engagement and epidemiological studies of war-related illnesses after a deployment also depend on accurate documentation of exposures. Data systems containing detailed records of duty locations and environmental exposures, such as those discussed by one of the companion reports to this one, *Strategies to Protect the Health of Deployed U.S. Forces: Detecting, Characterizing, and Documenting Exposures* (National Research Council 1999b), must be interfaced with the CPR so that links between exposures and illnesses can be studied and adverse health effects can be treated or prevented.

Databases for Epidemiologic Studies

It is crucial that health information collected from individuals be gathered in a manner that permits asking epidemiologic questions about deployed populations. Two unmet requirements after past deployments have been the need to conduct good epidemiologic studies of the effects of putative deployment exposures and the need for information to assess the long-term health status of deployed individuals. Meeting these needs requires record-keeping systems that can link personnel information, location information, individual exposure information, and health outcome information.

Longitudinal Record Keeping

Manifestations of the health effects of war are often delayed and are sometimes prolonged. Consequently, information-gathering activities should continue for years, perhaps indefinitely, after discharge from the military, as discussed in Chapter 4. For discharged service members who later receive their health care from VA, ongoing follow-up requires interfaces between VA and DoD health information systems. For service members and reservists who receive care from civilian health care providers, mechanisms for the capture of essential health data from the Recruit Assessment Program (RAP) and Health Evaluation and Assessment Review (HEAR) instruments are necessary.

Defining, understanding, treating, and preventing illnesses that follow deployment of U.S. troops require diligent and comprehensive record keeping. The following section examines some of the major information systems activities under way and planned in DoD.

MAJOR INFORMATION SYSTEMS ACTIVITIES

To gain an understanding of the ongoing information systems activities in support of Force Health Protection, the study team heard briefings on several projects including the Composite Health Care System (CHCS), the Government CPR (GCPR) project, the Preventive Health Care Application (PHCA), the Personal Information Carrier (PIC), and various survey instruments. Observations for each project area are summarized below.

Composite Health Care System

The CHCS is a clinical information system project that began in the early 1980s. The scope of clinical information stored in CHCS is currently limited to ancillary data such as laboratory results and pharmacy data. CHCS is deployed at 86 medical treatment facilities worldwide, and each CHCS stores data in a local database. Unfortunately, data from the local databases cannot be linked to construct a consolidated database. The lack of data integration also makes it difficult to provide a continuous record for service members. The study team heard several examples of the difficulties in accessing information from disparate CHCSs. For example, when a service member changes duty stations or is deployed, data stored in one CHCS cannot be transferred to the CHCS at another location. Laboratory data critical to effective medical surveillance can be transferred to another facility only by electronic mail because laboratory results are stored in local CHCS databases. The CHCS hardware and software were described as "difficult and expensive to operate and maintain, and the system has an architecture that does not readily provide expansion of capabilities to meet current and future military health system mission needs" (U.S. Department of Defense, 1998a). Because of the limitations of CHCS, a second phase of CHCS (CHCS II) was initiated in 1997, and the original program was named CHCS I.

The CHCS II program includes development of a CPR, immunization tracking, health risk assessment, pre- and postdeployment health status tracking, and security services. CHCS II has been planned as a "system of systems" (U.S. Department of Defense, 1999c). A "best-of-breed" approach (an approach that identifies applications that serve specific tasks and interfaces them to a central system) has been adopted as the strategy for information systems in the military health system. Although this strategy takes advantage of multiple niche products, it presents a significant challenge to data integration because the different products do not share a common data model or database (Hammond, 1999; McDonald, 1999). The best-of-breed approach tends to favor growth of independent, task-specific applications without sufficient consideration of the overall integration strategy. The need for data integration must be proactively interjected into the process of defining, specifying, and prioritizing information requirements. To the extent possible, the needs of all three services should be considered concurrently to maximize reuse of data and software programs. Attempts to combine data gathered from different applications into a single database are fraught with difficulty and often are not possible. Development and maintenance of interfaces to multiple systems requires substantial effort and must be updated every time any one program is updated. To work at all, there must be a well-articulated and precisely defined technical architecture that spans all branches of the military. Similarly, a common approach to data standards by all who need data (e.g., caregivers, epidemiologists, and preventive medicine professionals) should be adopted. Otherwise, the same or similar data will be collected multiple times instead of being collected once and reused (Hammond, 1999; McDonald, 1999).

A consistent theme observed throughout the briefings was a mutual lack of awareness and coordination among the various project participants involved with information-gathering activities and systems. In general, each need for data has been addressed by a separate data-gathering activity at the individual service level. It was common to find that each branch of the military had its own processes and programs for the gathering of data. Effective central oversight authority common to all three services to ensure that independent efforts are coordinated or, better yet, consolidated into a single activity that serves the needs of all three services was not apparent. The study team received very few details about the implementation plans and milestones for many of the important medical record-keeping projects including CHCS II, the final common pathway for information systems projects. Although the intent is that all applications be integrated into CHCS II, the study team heard no concrete technical plans for the integration. In addition, it is not clear that CHCS II data from different regions will be consolidated. According to one briefing, CHCS I data will not be integrated with CHCS II data (L. Ray, 1998). Compromising the ability to share data among applications would undermine the vision of creating a uniform CPR for all service members and would prolong the state of data fragmentation described in previous studies.

In addition to developing technical plans for data integration, organizational plans need to be developed to standardize policies and practices relating to medical record keeping. The study team heard of differences in policies between the services regarding whether certain information should be recorded and of differences in the forms used to record information. In short, whether and how medical information was recorded varied on the basis of the type of data involved (e.g., outpatient care, inpatient care, immunizations, or investigational drug use), the location of the service member (e.g., garrison, deployed, and location of deployment), and the branch of service. Policies, procedures, and practices should be standardized so that consistent and comprehensive data can be stored in the CPR throughout the military enterprise.

A new program, the Theater Medical Information Program, is planned to be a field-deployable system that will link information databases. It is planned to "support mission-critical information and data from across the areas of medical command and control, patient movement, medical logistics, health care delivery, and manpower, personnel, training, and resources" (U.S. Department of Defense, 1998b, p. 4). CHCS II is anticipated to be only one of many systems or modules that it links and integrates (U.S. Department of Defense, 1998c). Although CHCS II is scheduled to begin worldwide deployment in 2000 (U.S. Department of Defense, 1999f), many of its features and characteristics are still under development, and it is likely to be several years before it is ready to provide the functions described above. The Theater Medical Information Program is fully funded through 2004.

Since CHCS II will be a key component used by the Theater Medical Information Program for the care of the service member during a deployment, it is vital that the two systems work together well to meet the needs of deployment. CHCS II must be developed and implemented with a priority for the readiness mission.

A separate area of concern for the study team was the medical record-keeping needs of the reserve component. As described in Chapter 8, members of the reserves do not receive their health care from the military health system but from civilian providers through their employers' insurance or paid for by themselves. Thus medical records for reserve forces are not readily available to the military system. Because reservists increasingly constitute a significant portion of deployed forces, ensuring that health care providers have adequate information to care for reservists during deployments and that epidemiologists have sufficient population data for this group should be a high priority. The reserves are at increased risk of adverse health consequences (Iowa Persian Gulf Study Group, 1997), perhaps because of the episodic nature of their participation in the military. Consequently, the health information management needs of the reserve component should be explicitly addressed in the information systems strategy. Currently, they are not.

One means to acquire health status information from reserve members would be through annually administering the HEAR survey to members of the reserves, as recommended in Chapter 4, and through administering the RAP instrument to all recruits as currently planned by DoD and recommended in Chapter 4. It is important that data be captured electronically and be retrievable as part of a computerized patient record for reserve members. While such a CPR for reservists would not be as complete as that for those who are active-duty service members, it should provide information useful during deployments and for surveillance.

Government Computer-Based Patient Record Project

As part of his commitment to resolving the health information management issues that impeded study of Gulf War illnesses, the President directed DoD and VA to work together to ensure that service members' health information can be passed seamlessly from the military health system to VA (White House, 1997). In 1998, the GCPR project was established to accomplish this goal. The GCPR project is a cooperative venture involving the DoD, the Veterans Health Administration, and the Indian Health Service to facilitate seamless exchange of patient data among government health information systems. The effort is to be standards based and is to include input from and cooperation with private-sector standards-setting organizations. The study team applauds and supports the goals of the GCPR project. Their intention to work with and build on existing work of health care standards organizations (e.g., HL-7) is excellent. The early focus on building and refining reference models is well placed. However, the GCPR project team may be underestimating the level of effort and time required to make substantive progress in this area. For example, the Institute of Electrical and Electronic Engineers' MEDIX standards group and HL-7 have been working on the Reference Information Model (RIM) for over 12 years. It may be unrealistic to expect that the GCPR project team can complete an information model, even of a limited domain, in a matter of a year. The model of any one domain is interrelated with the global, or overall model. Furthermore, their plan to draw on available bodies of work, extend them to meet GCPR needs, and make those extensions available to the international community (GCPR Framework Project, 1999c) is not part of the standards-development process. Such "extensions" performed outside the context of the consensus-based standards process tend to cause divergence from standardization, rather than to strengthen it.

Due to a delay in finalizing the contract with the prime contractor, the study team did not receive any details of the proposed architecture, project plans, and implementation approach during the workshop briefings. While the draft report was being reviewed, the study team received two documents providing an overview of the technical architecture proposed by Litton/PRC for the GCPR Framework, the basis for developing a "virtual" longitudinal patient record (GCPR Framework Project, 1999b,c). The overview document (GCPR Framework Project, 1999b) describes an architecture that relies on a proposed standard for distributed object services (CORBA—Common Object Request Broker Architecture) to identify the patient, locate the various repositories of patient information, translate the meanings of data in heritage systems (existing systems of DoD, VA, and HIS) into a common information model, and ensure system security. The project plans to integrate heritage systems, commercial off-the-shelf systems, and government off-the-shelf systems in a "best-of-breed" approach.

The GCPR team is committed to demonstrating the ability of their Framework to: "(1) share patient data with no loss of meaning or usefulness, and (2) be able to cooperate in the joint execution of tasks" (GCPR Framework Project, 1999b, p. 3). It is important that the proof of concept prototype demonstrate the

Framework's ability to meet these objectives. For example, using their chosen domain of laboratory data, it would be useful to evaluate the Framework's ability to mediate the application of decision support rules stored in one system to laboratory data that are combined from other heterogeneous data sources.

The study team and external advisors find the architecture described to be reasonable conceptually, but are concerned about the feasibility, practicality, cost, and maintainability of the approach. Within a limited domain (e.g., exchanging lab test results), it should be possible to develop a proof-of-concept prototype as proposed by the GCPR project team. The challenge will be to assess the scalability of both technical and non-technical aspects of the prototype to a large health system the size of the DoD, VA, and IHS.

A key element of the proposed GCPR Framework is the virtual database, "a single interface to a variety of distributed, heterogeneous data sources" (GCPR Framework Project, 1999b, p. 8). While it is technically possible to wrap (that is, translate a proprietary interface into a standard interface) heritage systems in a CORBA environment, the ability to maintain the "meaning and usefulness" of the data will prove quite challenging. Although a CORBA-wrapped object may be able to communicate with other CORBA components and services, limitations in the heritage system will persist. For example, if some context of data (e.g., date/time stamp, authentication of the person entering data, medications being taken by patient) were not stored in the heritage system, it will be impossible to answer a query requiring such information. Another example where wrapping heritage systems will not necessarily satisfy critical system requirements involves security. The documents mention encryption and digital certificates—techniques to secure communication of data, but do not address the administrative security features needed in each repository to protect identifiable patient information. If a heritage system does not support role-based access or does not record audit trails of all accesses and updates, applying a CORBA wrapper will not raise the functional capabilities of the system to meet Health Insurance Portability and Accountability Act (P.L. 104-191) requirements.

The GCPR documents do not describe how deficits in data collection will be handled to achieve the goals of medical record keeping and medical surveillance. For example, if some important information (e.g., exposure data) is not captured in the heritage system, the feasibility of conducting recommended medical surveillance activities will be limited. If the goal of the GCPR project is merely to access existing data in legacy systems, a simpler Web-based approach could be entertained. A key motivation for creating a computer-based patient record is to efficiently capture comprehensive information about all service members and to make relevant views of that information available to decision makers. Consequently, accommodating the need for entering new data and reconciling data elements among the various heritage systems should be addressed in the architectural plans.

The information management component of the GCPR Framework acts to synthesize "a virtual patient record . . . out of disparate records stored on different systems in different locations" (GCPR Framework Project, 1999b, p. 11).

The GCPR project team proposes to accomplish this "by unifying the information in these records in a common representation, by using a clinical lexicon to standardize terminology and a Common Information Model to provide a shared semantic base of understanding" (p. 11). The study team has significant concerns about the feasibility of this goal, since none of the needed standards currently exists or is likely to be developed in the next few years. No acknowledgment is made of the costs of developing or maintaining such standards. It is also not clear how changes made to the heritage systems will be incorporated into the information model and how these would propagate to other systems that may rely on the data from the source system.

The original time line presented to the study team called for operation of a proof-of-concept laboratory version of a virtual patient database (linking data from heritage systems) by September 1999, and for operation of a full pilot system by February 2000, followed by testing at a live site. More recent time lines call for the prototype phase to finish by February 2000, the pilot tests to finish by March 2001, and enterprisewide implementation by August 2002 (GCPR Framework Project, 1999d). Given the people and organizational challenges associated with standards development and the technical complexity of the project, the study team is concerned that the project will not meet its goals according to the proposed time lines.

Health Assessment Instruments

To gather health information from all service members, a number of survey instruments have been or are being developed. The study team was briefed about plans to automate several of the health assessment instruments that were described in Chapter 4. The study team's summarized observations are below.

Preventive Health Care Application

PHCA includes two modules: software to capture data from the Health Evaluation and Assessment Review (HEAR) survey and an immunization tracking module (ITM) (U.S. Department of Defense, 1999e). Deployment of PHCA with HEAR began in the spring of 1999; ITM entered beta testing in February 1999. Both applications draw on data stored in the local, stand-alone PHCA database. PHCA receives demographic data from CHCS I through a one-way interface. Data stored in the local PHCA database cannot be uploaded to CHCS I.

The study team attended separate demonstrations (different vendors were involved) of HEAR and ITM. The computer-based implementation of the HEAR survey was a verbatim translation of the paper-based survey form. Although there are many opportunities to streamline the data-collection process when the paper-based survey is converted to a computer-based format, the program did not take substantial advantage of that capability beyond incorporating skips to appropriate questions.

The second component of PHCA is ITM. The ITM software is divided into several modules, most of which communicate with each other through batch processes. Multiple vendors are involved. The ITM program downloads demographic information (which originates from CHCS) from the local PHCA. It downloads vaccine supply data from a separate vaccine inventory program through a batch interface. During mass immunizations, a stand-alone program called Mass Immunization (MI) is used on a laptop computer to track immunizations. MI downloads demographic data from ITM. Once immunization data are entered into MI, they are uploaded to ITM and are subsequently uploaded to the Defense Eligibility Enrollment Reporting System (DEERS). The study team was struck by the use of several different software programs, many written by different vendors, to document the administration of a vaccine. PHCA has not been used during the ongoing mass anthrax immunization program because it was not yet fully developed at the start of the immunizations. Instead, each service adapted a different service-specific system to track anthrax immunizations before uploading the information into DEERS. DEERS itself is primarily an administrative system; its use for medical records was an expedient made necessary because the medical records systems were not adequate.

The study team was particularly concerned that PHCA data from HEAR and ITM were stored in a local database at the medical treatment facility. Consequently, medical surveillance data gathered through the HEAR survey resides locally. If an individual transfers to another duty station, HEAR data would have to be transferred by filling out a paper form (DD Form 2766) and hand entered into the PHCA system at the new station. The stand-alone nature of PHCA substantially limits its utility as a repository of patient information and as a medical surveillance tool. It is planned that PHCA will be able to upload data for transfer when CHCS II is implemented, although concrete plans have not yet been defined (ACS Government Solutions Group, 1999).

Pre- and Postdeployment Questionnaires

The current pre- and postdeployment health assessment questionnaires (which can be found in Appendix J) are intended to be administered immediately before and after a deployment, respectively. The questionnaires consist of scannable forms, and the data are stored at the U.S. Army Center for Health Promotion and Preventive Medicine. These data are not yet linked to HEAR data or to other health data. It was not clear that the data have been used in any decision making to date.

Recruit Assessment Program

A new questionnaire that is planned to be administered as the Recruit Assessment Program is being developed to collect baseline data on all U.S. military recruits. The intent is to collect data on a scannable form. Since the program is still entering a pilot stage, no decision has yet been made regarding the computer program into which the data will be entered or how much of the data-collection activity will be coordinated with the HEAR survey program or the pre- and postdeployment questionnaire activities.

Overall, the study team was concerned about the lack of coordination among the various data-gathering projects in the different services. Although most of the survey developers expected data from their surveys to be entered into a computer, each survey typically uses its own dedicated software program. Epidemiology researchers and preventive medicine professionals were not adequately consulted in the development of many of the survey instruments. Understanding the requirements of both the primary and the secondary users of data at the outset would improve the chances of designing a common survey instrument that serves multiple purposes. Minimizing the number of surveys administered and their frequency of administration is highly desirable, considering the logistical challenges associated with the collection of accurate data from troops being deployed. The ability to analyze aggregate data from multiple sites is critically dependent on the compatibility of the applications used to gather data and the database definitions used to store the data. One approach to ensuring comparable data is to use a common software application to gather the data. Another approach is to ensure that the multiple applications used comply with data standards so that the data can be integrated easily. Without establishing shared data standards ahead of time, data obtained through different software programs cannot be combined easily.

Deployment Medical Surveillance System

In the absence of CPRs, medical surveillance is fragmented and not available in real time. The study team heard of some special efforts to improve central reporting and surveillance during deployments. For example, the study team was briefed on the collection of disease and non-battle injury (DNBI) medical surveillance data from Bosnia and from Southwest Asia. In both theaters, diagnoses assigned to outpatient encounters are recorded in the sick-call log by using the 10th revision of the International Classification of Diseases. Twenty-five codes are used. These data are reported weekly to the Joint Task Force under the Joint Task Force surgeon.

The data have several limitations. One of the biggest challenges is ensuring that the encounter diagnoses are accurately abstracted from the progress notes. In general, the task of filling out the classification sheets is assigned to a nonclinician with no training in abstracting. Furthermore, the frequency with which reports are submitted may not be sufficient to detect important outbreaks or sentinel diseases. In addition, multiple diagnoses for individual subjects are coded as separate events, which may distort the percentage calculations. These surveillance data are stored on local servers and thus are not combined with other data. Without a central strategy for collection, consolidation, and analysis of field data, medical surveillance will continue to be fragmented and incomplete.

Another problem with incomplete data collection during deployments involves inpatient data. Both policies and practices differ significantly among different deployments and among the different services in the military. For example, inpatient data from Bosnia are sent to the Patient Accounting and Reporting Real-Time Tracking System (PARRTS), a central patient reporting and tracking database, whereas inpatient data from Southwest Asia are not because PARRTS is not expected to be part of the planned Theater Medical Information Program now under development. Furthermore, when a service member is treated in a host nation facility or at a military health system-sponsored facility, data are not captured in the medical surveillance system. Although more deployment surveillance data are being reported to central facilities now than during the Gulf War, collection, consolidation, and timely analysis of health data about U.S. troops are far from complete and systematic efforts to correct this situation are lacking.

Although the Theater Medical Information Program is planned to carry out the function of facilitating medical surveillance during deployments, it is likely to use modifications of existing programs. Developers should take into account the different demands of different deployment settings. Many of the problems identified above are not problems related to technology alone but are problems related to the training and equipment available to those carrying out necessarily active data-collection roles. An important change will be the implementation of systems that permit less active and time-intensive collection of data. If this change is implemented, medical surveillance will then involve the active scrutiny and analysis of data collected passively.

Personal Information Carrier

The study team was briefed about the PIC, which is being developed to store medical data in a form that service members could carry with them at all times. The PIC, which was conceptualized as a "smart card" (a computer processing unit and memory embedded in a small device), would store an individual's medical status and history, including medical documents, x-rays, and vaccination records (National Science and Technology Council, 1998). The study team heard a number of different purposes described for the PIC. At times it was described as the official complete medical record for each service member (U.S. Department of Defense, 1997c). At other times it was described as an information carrier to communicate information from the field to the central CPR (Page, 1999). Most recently, it is planned to "serve as the abridged Electronic Theater

Medical Record in settings where computer network connectivity is not available, providing in-theater health care providers with immediate access to accurate clinical information" (U.S. Department of Defense, 1999d, p. 1). The information on the PIC is to be read by a proprietary access device. Data would be transferred to a portable computer that would upload the PIC information to the central CPR periodically whenever a network connection was available.

The descriptions of the PIC did not justify clearly the use of high-capacity smart-card technology or adequately assess the feasibility of its use under adverse conditions such as the battlefield. Smart-card technology such as that proposed for the PIC has been proposed since the 1980s for possible application in civilian health care. To date, there have been no significant uses of the technology in any sizable installation. There are several reasons for the lack of success so far: (1) data on the card are frequently out of date (e.g., laboratory test results); (2) each card technology requires proprietary card readers, which are not widely available; (3) there is no predominant card technology; (4) there are no data content or format standards for the storage of data on the card; (5) the costs of the cards and the readers are significant; and (6) damage or loss of the card may result in lost information. Most of these issues apply to use by the military health system as well. Some additional requirements are unique to the military (e.g., durability, readability, and size). Earlier feasibility studies of PIC devices raised concerns about their tolerance of muddy conditions (U.S. Army Medical Department, 1997). Despite these limitations, however, there may be niche applications for PIC use in the military. One possible use would be to capture and communicate medical histories and interventions about a service member undergoing medical evacuation. For this use scenario, however, a PIC is needed only for cases of medical evacuation, not as a personal medical record for all service members. The logistical and financial implications of these two scenarios are drastically different. Although testing of candidate PICs is under way, a clear justification and use scenario is needed.

INFORMATION SYSTEMS ACQUISITION AND DEVELOPMENT PROCESS

Recognizing the need to consolidate 80 to 90 legacy information technology projects into a more manageable structure, in 1996 the military health system designated each military service to be responsible as executive agent for a subset of systems focused on a particular area of interest. The five areas of interest are clinical, logistics, resources, executive information, and theater medical systems. In February 1999, the five business areas, as well as information technology infrastructure and customer support, were consolidated under a single Program Executive Officer (PEO), who is responsible for all acquisition tasks necessary to support approved functional requirements (Tibbets, 1999a).

Functional requirements are developed by the Functional Integration Workgroup, consisting of clinicians, resource managers, logisticians, and health care administrators who are senior officers below the general or flag rank. The information requirements are reviewed by the military health system Program Review Board, consisting of the medical chief information officers of the Army, Navy, Air Force, and the military health system, as well as representatives of the medical comptrollers of the Army, Navy, and Air Force. The information requirements are sent to the Theater Functional Steering Committee for approval, and then are approved and funded by the Information Management Proponent Committee (Tibbets, 1999b).

Once the information technology projects are prioritized and funded, the approved projects are sent to the PEO for implementation (U.S. Department of Defense, 1999b). The PEO has full life-cycle responsibility for the approved projects, including development or procurement, worldwide deployment, and operation of the systems. Work is outsourced to industry through competitively awarded contracts. In time, the PEO plans to migrate the military health system to an information technology architecture that consists of multiple software applications running in a single worldwide network computing environment, providing for progressively greater degrees of information interoperability, data center consolidation, and remote management of information technology assets from data center to desktop (Tibbets, 1999a).

While the study team notes that the previous process for prioritizing, funding, and procuring information technology seemed to encourage selection of individual systems to address individual needs, it is not yet clear how well the new system will work to encourage development of an architecture to accommodate the diverse needs. The study team urges continued emphasis on broad-based input to the development of functional requirements, and external input as feasible throughout the process.

CONFIDENTIALITY OF HEALTH INFORMATION

Given the mandatory nature of health data collection in the military, including the collection of sensitive information (e.g., human immunodeficiency virus infection status and mental health status), stringent regulations, policies, and procedures are necessary to maintain system security and to protect the confidential health information of all service members and their dependents. Included in the legislative mandates of the Health Insurance Portability and Accountability Act of 1996 (P.L. 104-191) are provisions governing system security and the confidentiality of patient data (Health Insurance Portability and Accountability Act of 1996, 1996). When they become law, the military will have to comply with them in the same manner that civilian providers do. The Secretary of Health and Human Services released the Notice of Proposed Rule Making for security regulations in August 1998, drawing heavily on the recommendations of the Institute of Medicine study of current security practices (National Research Council, 1997). Final regulations are expected by the end of 1999.

SUMMARY

There are many challenges to the development, implementation, and maintenance of a health information system to serve the diverse needs of the military. It is not surprising that there are separate activities in each of the services. In some cases these are driven by immediate needs, and in other cases they arise out of a lack of awareness of existing solutions or projects under way elsewhere in the military. To meet the health needs of U.S. forces deployed abroad, however, a unified CPR system that supports the readiness mission is essential. At the core of a unified record is a common data model and common data content definitions that facilitate integration of data from distributed sites and systems. Interfacing of the data from heritage systems will continue to pose substantial barriers to conducting medical surveillance and epidemiological studies of the health of and illnesses suffered by deployed troops. Data integration should be the goal from the beginning. Acquisition and development plans should begin with a clearly articulated technical architecture, a common data model, and common data standards.

The process of developing an integrated CPR for the military health care system is complex, yet it is essential to ensure military readiness and a healthy force. It involves tremendous expenditures of money and resources and requires extensive expertise. With so much at stake, the study team recommends that an external advisory board participate in the effort by providing ongoing review and advice regarding the military health information systems strategy. Composed of members of academia, industry, and other governmental organizations such as the National Library of Medicine, this group would provide synergy and potential leverage between the military and civilian health information system sectors. The study team believes that this partnership will increase the likelihood of success for the overall endeavor.

The study team recommends that a comprehensive review of the military health information systems strategy be undertaken to enumerate the information needs; define an expedient process for the development of an enterprisewide technical architecture, common data model, and common data standards; identify critical dependencies; establish realistic time lines; assess the adequacy of resources; and perform a realistic risk assessment with contingency plans. A truly integrated CPR accessible for medical care, medical surveillance, and epidemiological research is absolutely essential to the health and readiness of U.S. troops deployed abroad. A thoughtful review of the current strategy will increase the chance of success.

FINDINGS AND RECOMMENDATIONS

Finding 5-1: Medical information system development and acquisition within the U.S. Department of Defense have been piecemeal. There is no clear effective central authority to ensure that data from all software systems can be consolidated to serve the needs of those involved with individual care and medical surveillance.

Recommendation 5-1: Clarify leadership authority and accountability for establishment of an integrated approach to the development, implementation, and evaluation of information system applications across the military services. Establish a top-level technical oversight committee responsible for approving all architectural decisions and ensuring that all application component selections meet architecture and data standards requirements.

Finding 5-2: Several current and proposed information systems address task-specific information needs at a local level without sufficient consideration of the overall integration strategy and the need for a common architecture. Thus, multiple overlapping projects address similar information requirements.

Recommendation 5-2: Coordinate the evaluation of information needs for maximum reuse of data elements, data-gathering instruments (e.g., surveys), and software systems across the military health system.

- Assess information requirements across the military enterprise in the context of a global data model and a common architecture for the computer-based patient record.
- Include primary and secondary data users (e.g., preventive medicine professionals and epidemiologists) in the process of specifying, selecting, and developing data-gathering instruments and information systems.
- Analyze the logistical and work flow effects of data-gathering activities as part of the specification and design process.

Finding 5-3: Medical record-keeping practices vary widely on the basis of the type of data involved (e.g., outpatient care, inpatient care, and immunizations), the location where medical service is provided (e.g., a garrison or a deployment location), and the branch of service.

Recommendation 5-3: Develop standard enterprisewide policies and procedures for comprehensive medical record keeping that support the information needs of those involved with individual care, medical surveillance, and epidemiological studies.

Finding 5-4: There are many challenges to the development, implementation, and maintenance of a health information system to serve the diverse needs of the military. An assessment of the readiness of the information technology organization to meet the challenges according to the necessary time lines would alert the leadership to areas that require additional resources, management attention, or contingency planning. Ongoing external input could help to take into account benefits, costs, reliability, feasibility, cross-military ease of use, and the ability to use such systems for subsequent individual and population health studies.

Recommendation 5-4: Conduct an independent risk assessment of the military health information system strategy and implementation plan. Establish an external advisory board that reports to the Secretary of Defense and that is composed of members of academia, industry, and government organizations other than the Department of Defense and the Department of Veterans Affairs to provide ongoing review and advice regarding the military health information system's strategy and implementation.

Finding 5-5: The conceptual architecture proposed for the GCPR Framework Project provides an open-systems architecture to interface heritage applications with new applications. However, limitations of the heritage systems will impede development of fully integrated records and functional decision support. The study team is concerned about the feasibility, practicality, cost, and maintainability of the approach when scaled beyond the limited proof-of-concept prototype that is planned. The GCPR team acknowledges that "the technical solution being pursued in the GCPR Framework project has a moderate to high probability of failure . . . " (GCPR Framework Project, 1999a, p. 21).

Recommendation 5-5: To reduce the risks of the entire GCPR Framework Project, the GCPR project team should ensure that the Phase I prototype is sufficiently representative of the complexity expected for the total project. The prototype should include evaluation of the following:

- **Integration of data from heterogeneous sources while preserving the meaning of the original data**
- **Implementation of decision rules stored in one system acting on data from another system**
- **Entry of data in a new system and its reconciliation with data in heritage systems**
- **Incorporation of existing standards in the prototype and identification of gaps in available standards**
- **Measurement of performance characteristics of the virtual database and estimation of the performance of a comprehensive system with all the data components and middleware services in operation**
- **Estimation of the level of effort and costs of maintaining the middleware services**

Finding 5-6: The health information needs of reserve service members are not being adequately addressed. Although there are challenges to gathering data on reservists, no substantive initiative to acquire or link health data for this group exists.

Recommendation 5-6: Develop methods to gather and analyze retrievable, electronically stored health data on reservists. For example, ensure that data from the Recruit Assessment Program and the Health Evaluation and Assessment Review collected from reserves (as recommended in Chapter 4) are captured as part of a computerized record permitting retrievability and population-level analysis as well as the addition of new data from periods of deployment or activation.

Finding 5-7: The need for high-capacity smart-card technology for a universal personal information carrier is not clearly justified, and its fit with the remainder of the information infrastructure for the military system is not clearly articulated.

Recommendation 5-7: Reexamine the information requirements for the personal information carrier (PIC) and develop a justification for applying the appropriate technology to satisfy the information requirements.

- Identify specific scenarios for the use of the PIC and the relevant military population affected.
- Define the minimum data needed for the provision of care in the battlefield setting.
- Explore practical alternatives for the provision of access to necessary emergency information at the point of care and estimate the infrastructural costs associated with each option.

Finding 5-8: The military mission requires collection, storage, and communication of sensitive, individually identifiable health information for each service member.

Recommendation 5-8: Make available to service members the regulations, policies, and procedures regarding system security and protection of individually identifiable health information for each service member.

- Comply with all system security regulations adopted by the Secretary of Health and Human Services to the extent practical in the military.
- Develop confidentiality policies to comply with federal privacy legislation and regulations in accordance with the Health Insurance Portability and Accountability Act of 1996 (PL 104-191).

Finding 5-9: Funding of major projects is uneven. The Government Computer-Based Patient Record project operates year by year, the Theater Medical Information Program project is fully funded, and the second version of the Composite Health Care System project is funded for deployment but not additional development.

Recommendation 5-9: Treat the development of a lifetime computer-based patient record for service members as a major acquisition, with a commensurate level of high-level responsibility and accountability. Clear goals, strategies, implementation plans, milestones, and costs must be defined and approved.